INFLUENCE OF DESENSITIZING AGENTS ON THE MICRO-SHEAR BOND STRENGTH OF ADHESIVE SYSTEMS TO DENTIN

Fernando A. Maeda¹, Ana P.A. Guedes², Anderson Catelan², Sabrina Pavan¹, André L.F. Briso², Renato H. Sundfeld², Paulo H. dos Santos¹

¹Department of Dental Materials and Prosthodontics. ²Department of Restorative Dentistry. São Paulo State University – Araçatuba School of Dentistry, UNESP, Brazil.

ABSTRACT
The aim of this study was to evaluate the effect of desensitizing agents on the micro-shear bond strength of adhesive systems to dentin. Forty bovine teeth were divided into 8 groups (n=5): G1 - Single Bond (SB); G2 - G.H.F. + SB; G3 - Desensibilize + SB; G4 - Dessensiv + SB; G5 - Single Bond 2 (SB2); G6 - G.H.F. + SB2; G7 - Desensibilize + SB2; G8 - Dessensiv + SB2. In all of the groups, the desensitizing agents were applied after phosphoric acid etching and before the dentin adhesive application. Z250 composite resin tubes were bonded on the treated surface. After 24 hours, the teeth were tested in a universal machine. Data were submitted to ANOVA and Tukey’s test (5%). The results showed that the groups where Desensibilize and Dessensiv were applied exhibited smaller bond strength values.

Key words: desensitizing agents, dentinal adhesive, micro-shear bond strength.

RESUMO
O objetivo deste estudo foi avaliar o efeito dos agentes dessensibilizantes sobre a resistência de micro-cisalhamento de sistemas adesivos à dentina. Quarenta dentes bovinos foram divididos em 8 grupos (n = 5): G1 - Single Bond (SB); G2 - GHF + SB; G3 - Desensibilize + SB; G4 - Dessensiv + SB; G5 - Single Bond 2 (SB2); G6 - GHF + SB2; G7 - Desensibilize + SB2; G8 - Dessensiv + SB2. Em todos os grupos, os agentes dessensibilizantes foram aplicados após o condicionamento da dentina com ácido fosfórico e antes da aplicação adesiva. A resina composta Z250 foi colocada sobre a superfície tratada. Após 24 horas, os dentes foram submetidos ao teste em uma máquina universal. Os dados foram submetidos à ANOVA e teste de Tukey (5%). Os resultados mostraram que os grupos onde foram aplicados Desensibilize e Dessensiv exibiram menores valores de resistência ao micro-cisalhamento.

Palavras chave: agentes dessensibilizantes, adesivos dentinários, micro-cisalhamento.

INTRODUCTION
Post-operative sensitivity is commonly found in vital teeth after the use of adhesive systems that require acid etching. Some clinical studies have revealed the presence of post-operative discomfort in up to 14% subjects after the restorative procedure¹². Dentin sensitivity (DS) is a great challenge to the dentist³⁴. It is a painful clinical condition that affects 40 million Americans who present some kind of discomfort at any time during their life⁵. Murray⁶ (1994) reported that the mean prevalence of sensitive teeth is 14.8% in six countries around the world. Exposed dentin can be sensitive to mechanical, thermal or osmotic stimuli. The non-carious etiologies for DS are abrasion, abfraction or erosion lesions, gingival recession or periodontal therapy⁷. Abrasion is the most common loss of dental structure, caused by brushing techniques and the use of abrasive toothpaste. Abfraction is the loss of current dental structures, caused by traumatic occlusion loads. Erosion is the chemical dissolution of the dental structure, frequently caused by gastric acids, diet or the dental environment. DS can also be a post-operative complication associated with dental procedures. Morphological and physiological studies suggest that dentin hypersensitivity results from exposure of dentin surfaces to the oral environment⁸⁹. Nowadays, the most accepted theory to explain DS is the hydrodynamic theory of Brännström¹⁰ (1992), who suggested that dentin sensitivity originates after the
displacement of the tubular fluid, stimulating a nerve receptor, which results in the transmission of the stimuli\textsuperscript{10}.

Based on this hypothesis, desensitizing agents have been used for treatment of DS. These agents have different mechanisms of action, but generally seek to obliterate the dentin tubules, precipitate proteins that constitute Tomes process (silver nitrate, zinc chloride), inhibit the formation and deposition of crystals in the mouth and interior of the dentin tubules (fluoride compounds, strontium chloride, potassium oxalate), or cover the dentin by impregnation of the tubules. Finally, some agents employ dentin bonding agents with and without resin-based composite\textsuperscript{11,12}.

Few studies evaluating the effect of desensitizing on micro-shear bond strength of bonding agents to dentin have been reported in the literature. Thus, this study evaluated the influence of some desensitizing agents on the bond strength of adhesive systems to dentin.

**MATERIALS AND METHODS**

The compositions, manufacturers and batch numbers of the materials used in this study are listed in Table 1.

<table>
<thead>
<tr>
<th>Materials</th>
<th>Composition</th>
<th>Manufacturer</th>
<th>Batch #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adper Single Bond</td>
<td>Bis-GMA, HEMA, ethanol, water</td>
<td>3M ESPE, St. Paul, MN, USA</td>
<td>1GA</td>
</tr>
<tr>
<td>Adper Single Bond 2</td>
<td>Bis-GMA, HEMA, dimethacrylate, ethanol, water,</td>
<td>3M ESPE, Irvine, CA, USA</td>
<td>HYK</td>
</tr>
<tr>
<td>Z-250</td>
<td>Bis-GMA, UDMA, Bis-EMA, Zircon/silica</td>
<td>3M ESPE, St. Paul, MN, USA</td>
<td>5RF</td>
</tr>
<tr>
<td>Tooth Conditioner Gel</td>
<td>37% Phosphoric acid</td>
<td>Dentsply Latin America, Petrópolis, RJ, Brazil</td>
<td>242437</td>
</tr>
<tr>
<td>Desensibilize</td>
<td>Strontium chloride, potassium nitrate, water, thickener and humectant</td>
<td>FGM Produtos Odontológicos, Joinville, SC, Brazil</td>
<td>02 Mar 05</td>
</tr>
<tr>
<td>Dessensiv</td>
<td>Potassium oxalate, potassium fluoride, potassium nitrate, hydroxyethylcellulose, phosphoric acid and water</td>
<td>S.S. White, Rio de Janeiro, RJ, Brazil</td>
<td>003</td>
</tr>
<tr>
<td>G.H.F.</td>
<td>Glutaraldehyde, HEMA</td>
<td>Biodinâmica, Ibiporã, PR, Brazil</td>
<td>479/05</td>
</tr>
</tbody>
</table>

**Tooth preparation**

Forty bovine incisors were stored in distilled water at room temperature for 1 month until the beginning of the study. The teeth were cleaned and polished using pumice and water with a brush in a low-speed handpiece. The roots were sectioned and the crowns embedded in acrylic resin (Clássico, Dental Products, São Paulo, SP, Brazil) in PVC tubes, with the buccal surface 1 mm above the edge of the tube. The buccal surface of each tooth was ground with wet 180-, 400-, and 600-grit silicon carbide abrasive paper in a horizontal grinder (APL-4, Arotec, São Paulo, SP, Brazil) until a dentin surface was exposed. The exposed dentin surface was then examined using a 63X stereoscopic loupe (Carl Zeiss, Jena, Germany) for complete removal of enamel. Teeth were randomly divided into 8 groups (n=5), according to the bonding procedures.

**Bonding procedures**

All the samples were etched with 37% phosphoric acid for 15 seconds and rinsed with water for 20 seconds. The surfaces were gently dried with absorbing paper and submitted to the procedure described below (Table 2).
Z250 composite resin cylinders were prepared inserting the composite in Tygon-Microbone (TGY-030, Small Parts Inc.) tubes, 0.7 mm in internal diameter and 0.7 mm in height, and photo-cured for 20 seconds using Ultralux (Dabi Atlanti, Ribeirão Preto, Brazil) with 500 mW/cm², and the tip positioned close to the Tygon microtubes. After the procedure, the tubes were removed carefully. Three cylinders of Z250 composite resin were bonded with the dentin adhesive in each prepared tooth in all of the groups. All teeth were stored in distilled water for 24 hours at 37°C.

**Microshear bond test**
The samples were submitted to micro-shear bond testing in a universal machine EMIC (model DL 3000) operated at 0.5 mm/minute. For this procedure, an orthodontic wire - 0.3 mm in diameter and 5 mm in length - was used to form a loop involving the composite cylinder in the bonded area, inducing a tensile effort which generated a shear movement. The micro-shear bond strength was calculated by the following formula:

\[ R = \frac{F}{A} \]

where: R is the micro-shear bond strength; F is the applied force; and A is the bonded area.

The micro-shear bond strength values were submitted to two-way ANOVA and the averages compared by Tukey’s test (5%).

**RESULTS**
For Single Bond dentin adhesive, the control (23.79 ± 4.58 MPa) and G.H.F. (20.68 ± 3.82 MPa) groups exhibited the highest values of micro-shear bond strength, with no statistical difference between them (p>0.05). Similarly, these groups presented the highest values when Single Bond 2 was used as dentin adhesive (22.51 ± 2.13 MPa; 20.39 ± 4.28 MPa, respectively). The application of the agents, Dessensibilize and Dessensiv, decreased the micro-shear bond strength for Single Bond (16.04 ± 2.91 MPa; 14.85 ± 2.11 MPa) and Single Bond 2 (15.02 ± 0.75 MPa; 15.97 ± 2.51 MPa) (p<0.05). These results are shown in Fig. 1.

Fig. 2 demonstrates that, in all of the studied groups, there was no statistically significant difference in micro-shear bond strength between the two dentin adhesives (p>0.05).

**DISCUSSION**
The choice of dentin adhesive should consider both its final adhesion to dentine and its capacity to resist the stress generated by the polymerization of the restoring material, in order to avoid the invasion of bacteria and post-operative sensitivity.

Dentin desensitizing agents have been used before the application of dentin adhesives that require acid

<table>
<thead>
<tr>
<th>Group</th>
<th>Desensitizing agent</th>
<th>Wash</th>
<th>Adhesive</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>None</td>
<td>None</td>
<td>Single Bond</td>
</tr>
<tr>
<td>G2</td>
<td>G.H.F. (30s)</td>
<td>rinsed in water (60s)</td>
<td>Single Bond</td>
</tr>
<tr>
<td>G3</td>
<td>Desensibilize (10 min)</td>
<td>rinsed in water (60s)</td>
<td>Single Bond</td>
</tr>
<tr>
<td>G4</td>
<td>Dessensiv (30s)</td>
<td>rinsed in water (60s)</td>
<td>Single Bond</td>
</tr>
<tr>
<td>G5</td>
<td>None</td>
<td>None</td>
<td>Single Bond 2</td>
</tr>
<tr>
<td>G6</td>
<td>G.H.F. (30s)</td>
<td>rinsed in water (60s)</td>
<td>Single Bond 2</td>
</tr>
<tr>
<td>G7</td>
<td>Desensibilize (10 min)</td>
<td>rinsed in water (60s)</td>
<td>Single Bond 2</td>
</tr>
<tr>
<td>G8</td>
<td>Dessensiv (30s)</td>
<td>rinsed in water (60s)</td>
<td>Single Bond 2</td>
</tr>
</tbody>
</table>

**Table 2: Bonding procedures in the tested groups**

![Fig. 1: Micro-shear bond strength, comparing the groups for both Single Bond and Single Bond 2 dentin adhesives. Bars with different letters are statistically different (p<0.05).](image)
etching, to prevent dentin sensitivity. According to Brannström’s Hydrodynamic theory\(^\text{10}\) (1992), dentin sensitivity originates from the dentinal fluid displacement due to dentin exposure. Within this context, desensitizing agents act as a type of plosive, obliterating the dental tubules.

G.H.F. is a desensitizing agent, containing glutaraldehyde and HEMA. Glutaraldehyde is believed to provoke dentinal fluid protein coagulation, and coagulation is facilitated by HEMA that is highly water soluble.\(^\text{14,15}\)

Some researchers have reported the clinical efficiency of glutaraldehyde and HEMA containing products in the treatment of dentin hypersensitivity\(^\text{16,17}\). Prior application of G.H.F. did not show any statistical difference with the control groups for both the adhesives under study (Figure 1). These results agree with those obtained by Cobb\(^\text{18}\) et al. (1997), Reinhardt\(^\text{19}\) et al. (1995) and Soeno\(^\text{20}\) et al. (2001), who used a product containing glutaraldehyde and HEMA, that did not interfere in the bonding of resinous cements to the dentine. In our study, however, the product was applied before acid conditioning.

The efficiency of adhesion is related to factors such as viscosity and degree of conversion of the adhesive and the collapse of the collagen fibril mesh that may hinder the penetration of the monomers into the interfibril spaces and the complete involvement of the collagen fibrils exposed for conditioning etching\(^\text{21,22}\).

The groups treated with Desensibilize demonstrated a reduction in bond strength that was statistically significant in relation to the control groups for both adhesives under study. Desensibilize contains strontium chloride in its composition; the decrease in bond strength observed with this material may be due to the deposition of crystals, formed by the change in the calcium of the dentine as a result of its interaction with strontium. Seara\(^\text{23}\) et al. (2002) reported that the formation of acid-resistant crystals is caused by the reaction between strontium chloride and dentin and could inhibit, chemically and/or physically, the permeability of dentin and mechanical retention among the resinous monomers in the dentin. Permeability would be one of the most important factors in incomplete infiltration of the adhesive, decreasing the bond strength to dentin\(^\text{24}\). In some studies, the use of desensitizing agents reduced dentin permeability by 80%\(^\text{25-27}\).

The application of Dessensiv caused a decrease in the micro-shear bond strength for both adhesives when compared with the control groups (Fig. 1). This effect could be attributed to the presence of potassium oxalate, which reacts with the dentin, forming calcium oxalate crystals. This result is in keeping with Al Qahtani\(^\text{28}\) et al. (2003) and Haveman & Charlton\(^\text{29}\) (1994), who obtained lower values when desensitizing materials with potassium oxalate in their composition were used.

The compositions of Single Bond and Single Bond 2 dentin adhesives are similar, with the latter including 10% w/w spherical 5 nm diameter silica particles. It is suggested by the manufacturer that the nanoparticles may create a more uniform hybrid layer, and contribute to increasing the bond strength to dentin. However, in our study, no difference in the micro-shear bond strength was observed, even in the treated groups (Fig. 2).

**CONCLUSION**

The results obtained in this study suggest that G.H.F. does not interfere in the micro-shear bond strength of dentin adhesives to dentin; however, the desensitizing agents, Desensibilize and Dessensiv, reduced the bond strength when Single Bond and Single Bond 2 were used.
REFERENCES